

Pajaro Valley Groundwater Basin

- Groundwater Basin Number: 3-2
- County: Santa Cruz, Monterey, and a small portion of northwestern San Benito County.
- Surface Area: 76,800 acres (120 square miles)

Basin Boundaries and Hydrology

The Pajaro Valley basin is bounded to the west by Monterey Bay and to the east by the San Andreas Fault, adjacent pre-Quaternary formations, and the Santa Cruz Mountains beyond. The basin's northern boundary is the surface expression of the geologic contact between Quaternary alluvium of the Pajaro Valley and marine sedimentary deposits of the Pliocene Purisima Formation. The southern basin boundary is a drainage divide in the Carneros Hills between the Elkhorn Slough to the north and the Moro Cojo Slough and lower Salinas River valley and the Salinas Valley-Langleigh groundwater subbasin to the south.

The Pajaro River and its tributaries including Corralitos, Salsipuedes, Browns Valley, Green Valley, and Casserly Creeks drain the Pajaro basin. Additional drainage is supplied by Carneros Creek in Monterey County. In the northwestern region of the Pajaro Valley a network of sloughs provides drainage (RMC 2001). The mean annual precipitation within the Pajaro Valley ranges from 16 inches near the coast to more than 40 inches in the Santa Cruz Mountains. The average rainfall for the City of Watsonville is 21.7 inches for a 60-year period of record.

Hydrogeologic Information

Water Bearing Formations

From oldest to youngest, the water-bearing geologic units comprising the Pajaro Valley groundwater basin include the Purisima Formation, the Aromas Red Sands, Terrace and Pleistocene Eolian Deposits, Quaternary alluvium and Dune Deposits (RMC 2001). Despite increases in the amount of information available, the fundamental understanding of the basin geology has not changed significantly since 1953 (RMC 2001).

The alluvium is composed of Pleistocene terrace deposits, which is overlain by Holocene alluvium and then by Holocene dune sands; the dune sands are largely unsaturated (Muir 1972). The average thickness of these deposits is 50 - 300 feet (RMC 2000a). Terrace deposits consist of unconsolidated basal gravel, sand, silt, and clay; alluvium consists of sand, gravel and clay deposited in the Pajaro River flood plain (PVWMA 2001). The basal gravel has good hydraulic continuity with the underlying Aromas Red Sands Formation and is a major source of water for shallow wells in the Pajaro River floodplain (MW 1993b).

The Aromas Red Sands Formation is composed of friable, quartzose, well-sorted brown to red sands that are generally medium-grained and weakly cemented with iron oxide. The thickness of this formation ranges from 100 feet in the foothills to nearly 900 feet below sea level near the mouth of the Pajaro River (Allen 1946). The formation consists of upper eolian and lower fluvial sand units that are separated by confining layers of interbedded clays

and silty clay. The Aromas sands are considered the primary water-bearing unit of the basin (PVWMA 2001), although, the water producing zones within the Aromas Red Sands formation can vary greatly in their ability to transmit water (RMC 2001).

Mostly marine in origin, the Purisima Formation is a thick sequence of highly variable sediments ranging from extensive shale beds near its base to continental deposits in its upper portion (PVWMA 2001). The thickness of this formation varies from 1,000 to 2,000 feet in the central portion of the valley to approximately 4,000 feet in the down-dropped graben between the San Andreas and Zayante-Vergales faults (Clark 1970). The sediments are chiefly poorly indurated, moderately permeable gravel, sands, silts, and silty clays. In the valley portion of the basin, the Purisima has been developed to a minor degree. Hydrologically, the most important outcrops are north and east of Pajaro Valley where this unit acts as a source of recharge to the basin.

Restrictive Structures

Two northwest-trending faults, the San Andreas and the Zayante-Vergales, cross the eastern side of the basin. Impermeable volcanic rocks juxtaposed against the marine sediments to the east of the San Andreas act as a barrier to ground water flow into or out of the groundwater basin (RMC 2001). Relatively impermeable clays found in Elkhorn Slough to the south of the Pajaro Valley form a barrier to north-south groundwater flows, creating a well defined geologic flow barrier near the slough mouth (RMC 2001).

Recharge Areas

Basin recharge occurs through direct percolation of rainfall and streamflow seepage from the Pajaro River and its tributaries and percolation of irrigation water. Recharge to the aquifers below the clay layers generally takes place in the eastern portions of the basin, where clay layers are not laterally continuous and occur as lenticular deposits (RMC 2001). A high potential for streamflow recharge to shallow aquifers (Alluvial and Aromas) exists in the Corralitos Creek watershed due to the lack of clay layers in the sedimentary sequence. Coastal dune sand deposits provide some recharge to shallow aquifers due to their high permeability and the lack of a confining layer at depth (EIP 1993). Recharge from dune sands may also provide protection from seawater intrusion through the development of a hydrostatic barrier in these areas (RMC 2001).

The primary confining clays are thickest in the middle of the Pajaro Valley and trend roughly parallel to the Pajaro River; they thin inland toward Watsonville and the mountains. As one moves to the northeastern portion of the basin, the clay layer becomes thinner and discontinuous. Near the coast, in the terrace areas, the clays are either absent, thinly layered, or discontinuous.

Groundwater Level Trends

Historically groundwater levels were higher than today in inland areas, while artesian conditions existed at the coast. Pajaro Valley groundwater levels have been in a decreasing trend due to pumping in excess of recharge. By the 1940's some wells were still artesian, but only in the winter months. By

the 1970s, however, water levels west of Watsonville were consistently below sea level from approximately May to December, often never recovering to levels above sea level (RMC 2001). Groundwater level trends were highly affected by the 1985-1992 drought. In March of 2000, 34 square miles of the 110 square mile basin had water levels less than sea level. In September 2000, this area was 51 square miles (PVWMA 2001).

Groundwater Storage

The total storage capacity of the basin is estimated to be 2,000,000 af above the Purisima Formation (LSCE 1987a). If the storage from the upper Purisima Formation is included, then the estimate of total storage capacity of the basin is 7,770,000 af (MW 1993a). Between 1964 and 1997, there has been an estimated loss of 300,000 af of freshwater storage from the basin. Approximately 200,000 af of this freshwater storage loss is due to seawater intrusion, while 100,000 af is due to conditions of chronic overdraft and resultant falling groundwater levels (RMC 2000b).

Groundwater Budget (Type A)

A detailed groundwater budget has been calculated for this basin from 1964 to 1997 (MW 1993a, b and RMC 2000b). On average, total recharge into the basin is estimated to be 61,000 af per year. There is no artificial recharge. Recharge resulting from precipitation and applied water use is estimated to be 35,000 af per year. Stream recharge is approximately 16,000 af per year. Recharge from seawater intrusion accounts for approximately 6,000 af of recharge per year. Recharge from seawater is also counted as a loss of freshwater storage. Average annual subsurface inflow is estimated to be 4,000 af per year. Annual urban and agricultural extractions, and estimates of other extractions, have been calculated from total pumpage given in the water budget and relevant historical use. Annual urban and agricultural extractions are on average approximately 10,600 af per year and 53,000 af per year, respectively. Other extractions average 3,600 af per year, and include rural residential pumping. Subsurface outflow to the Monterey Bay averages 2,000 af per year.

The sustainable yield of the Pajaro Valley groundwater basin was estimated using the Pajaro Valley Integrated Ground and Surface water Model (PVIGSM). The PVIGSM is a finite-differencing model that simulates the groundwater conditions in the Pajaro Valley groundwater basin using geologic and hydrologic conditions, current pumping conditions, and other basin characteristics. The modeling approach involved incremental reductions of groundwater pumping estimates until stable groundwater levels were observed (i.e., recharge = demand) and seawater intrusion was eliminated (RMC 2001).

The model results indicate that under current pumping conditions the sustainable yield of the basin is 24,000 af per year. However, the sustainable yield could be increased to 48,000 af per year by eliminating pumping at the coast and replacing the groundwater supply with water originating from a different source. The model indicates that this modification to current pumping practices would create a hydrostatic barrier that would prevent seawater intrusion (RMC 2001). Supplemental water will be required to

make up the remaining 22,000 af difference between safe yield and groundwater demand.

Groundwater Quality

Characterization. The groundwater of the Pajaro Basin can be separated into five differing chemical categories based on the concentration of dissolved ions in the water (Hanson 2001).

Category 1 is recent seawater intrusion. This category contains high concentrations of chloride, sodium, potassium, and sulfate. These waters are in the Upper and Lower Aromas sands near the coast and report the highest levels of TDS in the entire basin.

Category 2 is recent, or young, groundwater. These waters are found in the Eastern Section of the Basin in the Alluvial and Upper Aromas Aquifer at depths up to 300 feet. The water has high concentrations of calcium, magnesium, sulfate, chloride, and boron. This water was most recently recharged to the aquifer. The TDS range for this water category is 300 - 1,100 mg/L depending on the source of the recharging water (Pajaro River, Corralitos and Carneros Creeks, precipitation, and applied water).

Category 3 is older groundwater. These waters are found in the Lower Aromas and Purisima Formations. The water has high concentrations of carbonate, bi-carbonate, calcium, and magnesium. The TDS range for this water category is 300 - 600 mg/L. This is the best quality groundwater in the basin because it is outside of the spheres of influence of the seawater intrusion and the plume of poor quality water associated with Pajaro River water infiltration and is below the laterally continuous clay layers and therefore not susceptible to Nitrate loading.

Category 4 is older seawater. This water category found in the Purisima in the western region of the Basin and is remnants of seawater left behind by fluctuations in sea level. This water has high concentrations of calcium, magnesium, sulfate, and chloride. This category differs from category 1 (new seawater) because the sodium concentration is much lower. This chemical difference can be used to determine the difference between water categories 1 and 4. The TDS range for this category is 3,000 –30,000 mg/L. Age dating methods may also be used to determine differences between categories

Category 5 is very old groundwater. This category is found in the eastern region of the Basin in the Purisima Aquifer because the elevation of this region was not under the influence of the sea level changes. These waters have relatively equal concentrations of sodium, potassium, calcium, and magnesium. Sulfate and chloride concentrations are higher than the carbonate and bi-carbonate for this water sample. This category is the oldest water sampled in the basin and has a TDS range of 500 - 1,300 mg/L.

Impairments. In the north, near La Selva Beach, the area intruded by seawater extends approximately 0.75 miles inland and is two miles wide. The intrusion zone near the mouth of the Pajaro River extends inland approximately 1.5 miles and is approximately three miles wide. The data

indicate that the seawater is intruding along the coast in the middle and lower portions of the Aromas sands and that poor-quality water is present in the deeper zones (RMC 2001). There are also localized areas of high hardness, nitrates, sulfates, iron, manganese, boron, heavy metals, and organics (EIP 1993). Nitrate contamination as a result of intensive agriculture and areas of high residential septic-tank density is of increasing concern in the Pajaro Valley (RMC 2001).

Water Quality in Public Supply Wells

Constituent Group ¹	Number of wells sampled ²	Number of wells with a concentration above an MCL ³
Inorganics – Primary	37	0
Radiological	34	0
Nitrates	37	0
Pesticides	41	1
VOCs and SOCs	42	0
Inorganics – Secondary	37	9

¹ A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).

² Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.

³ Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Production characteristics

Well yields (gal/min)		
Municipal/Irrigation	Range: 100 – 2,000	Average: 500 (Bader 1969)
Total depths (ft)		
Domestic	Range: 150 - 800	Average: insufficient data
Municipal/Irrigation	Range: 150 - 800	Average: insufficient data

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
Pajaro Valley Water Management Agency	Groundwater levels	49 monthly;
	Major ions	121 semi-annually;
City of Watsonville	Groundwater Levels	170 sampled semi-annual
City of Watsonville	Title 22 water quality	15 Daily
Department of Health Services (incl. cooperators)	Title 22 water quality	15 Varies
		149 Varies

Basin Management

Groundwater management:	PVWMA adopted a Basin Management Plan in 1993, which was revised in 2000 and again in 2001.
Water agencies	
Public	City of Watsonville, Aromas WD, Pajaro/Sunny Mesa CSD, Soquel Creek WD, Marina Coast WD.
Private	California Water Service

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